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Original Article

Factors associated with phlebitis in children using central venous catheters

Fatores associados à ocorrência de flebite em crianças em uso de cateter venoso central

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ABSTRACT

Objective: to analyze sociodemographic and clinical factors associated with the occurrence of phlebitis in children using central venous catheters. **Methods:** cross-sectional study conducted in a pediatric intensive care unit of a public hospital. The sample included children from birth to 14 years, 11 months, and 29 days. Data were collected using the Portuguese Phlebitis Scale (Brazilian-adapted and validated version). Descriptive and inferential analyses were performed. **Results:** a total of 101 children participated, predominantly male (59.4%), most aged 0–5 years (77.2%) and enrolled in preschool (82.2%). In 61.4% of cases, the catheter remained in place for ≥ 6 days, and 71.3% had involvement of only one organ system. Phlebitis was identified in 30.7% of the sample and was significantly associated with catheter dwell time ≥ 6 days (p<0.000). **Conclusion:** in children, phlebitis was associated with catheter dwell time of 6 days or longer. **Contributions to practice:** the findings underscore the need for systematic surveillance and rigorous catheter-monitoring protocols to prevent and promptly detect associated complications.
Descritores: Central Venous Catheters; Phlebitis; Child.

RESUMO

Objetivo: analisar os fatores sociodemográficos e clínicos associados à ocorrência de flebite em crianças em uso de cateter venoso central. **Métodos:** estudo transversal, realizado em uma unidade de terapia intensiva pediátrica de um hospital público. A amostra incluiu crianças de zero a 14 anos, 11 meses e 29 dias. Na coleta de dados, utilizou-se a Escala Portuguesa de Flebite - versão adaptada e validada para o Brasil. Utilizaram-se análises descritivas e inferenciais. **Resultados:** participaram 101 crianças, majoritariamente do sexo masculino 59,4%, com idades entre zero e cinco anos 77,2%, matriculadas na pré-escola 82,2%. Em 61,4% dos casos, o cateter permaneceu instalado por seis ou mais dias, e 71,3% das crianças apresentaram acometimento de apenas um sistema orgânico. A flebite foi identificada em 30,7% da amostra, com associação estatisticamente significativa entre sua ocorrência e o tempo de permanência do cateter igual ou superior a seis dias (p<0,001). **Conclusão:** a flebite em crianças foi associada ao tempo de permanência do cateter igual ou superior a seis dias. **Contribuições para a prática:** os achados reforçam a necessidade de vigilância sistemática e protocolos rigorosos de monitoramento de cateteres, visando prevenir e identificar precocemente complicações associadas.
Descritores: Cateteres Venosos Centrais; Flebite; Criança.

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Introduction

Central venous catheters (CVCs) are intravascular infusion systems whose distal tip is positioned in large-caliber vessels — usually the superior or inferior vena cava — while the proximal end remains externalized through the skin or implanted in a subcutaneous port for therapeutic administration[1]. The use of CVCs is essential in the complex care of children with severe and chronic illnesses[2].

CVCs are particularly indicated during prolonged stays in pediatric intensive care units (PICUs), where high-complexity venous access is required. Major applications include infusion of peripherally incompatible solutions, including those with high osmolality; concomitant administration of multiple drugs or large fluid volumes; chemotherapy for neoplasms[3]; continuous hemodynamic monitoring; long-term parenteral nutrition; and pharmacotherapy in patients with limited or unfeasible peripheral venous access[4]. They also reduce pain and discomfort related to repeated blood sampling and frequent venipuncture, and mitigate psychological stress for patients and families[5].

Nevertheless, the use of CVCs in pediatric patients is challenging due to anatomic constraints, especially thin and fragile veins[1]. Despite their importance in delivering safe and effective care to children[2], evidence indicates a high risk of CVC-related complications[6-7], such as vascular injury, hematoma, hemothorax, arrhythmias, pneumothorax, infections, phlebitis, and thrombosis[8].

Within this context, phlebitis — or vascular-access–related thrombophlebitis — is clinically relevant. It is an inflammatory process of the vein, often accompanied by pain or tenderness, erythema, edema, purulent exudate, or a palpable venous cord, and is classified according to a standard scale or specific definition[9]. Despite its frequency, phlebitis is not fully elucidated. Reported prevalence varies widely, reflecting differences in diagnostic criteria, study designs, patient selection, and follow-up duration[10].

Internationally, a study of pediatric patients aged 1–13 years using peripherally inserted CVCs reported a phlebitis prevalence of 15%[11]. In Brazil, this complication is a leading reason for catheter removal among newborns in neonatal intensive care units, affecting 23.5% of patients[12]. These findings show that phlebitis is a clinically important outcome, as it compromises the use of CVCs and often leads to unplanned removals[13].

Preventing this complication is a core responsibility of the nursing staff, who must adopt standardized practices for aseptic technique, catheter and site selection, dressing procedures, skin preparation, and replacement of administration sets, among other measures. Such practices are essential to reduce risk, minimize complications, and ensure patient safety during intravenous therapy[10].

Studies on CVC-associated phlebitis in pediatrics remain scarce, and published data on its prevalence and burden in children are limited[13-14]. Most investigations focus on peripheral venous catheters, underscoring a significant knowledge gap regarding the occurrence and impact of this complication in children with CVCs. Further evidence is needed to clarify mechanisms and risk factors underlying CVC-related complications after insertion[13].

Consequently, the prevalence of phlebitis in pediatric populations remains controversial, reinforcing the need for additional research[15]. Because of the role of CVCs in pediatric care[14] and the lack of consensus on the determinants of phlebitis in children[13], we posed the following guiding question: What sociodemographic and clinical factors are associated with the occurrence of phlebitis in children using CVCs?

Accordingly, this study aimed to analyze sociodemographic and clinical factors associated with the occurrence of phlebitis in children using central venous catheters.

Methods

Study design

This was a cross-sectional study reported in accordance with the Strengthening the Reporting of

Observational Studies in Epidemiology guidelines.

Population, sample, and eligibility criteria

The study population comprised children using CVCs regardless of insertion site (operating room, intensive care unit, or referring hospital) and date of cannulation. Inclusion criteria were age from birth to 11 years, 11 months, and 29 days; and hospitalization in the study hospital's PICU during the study period. Children who died within 2 hours of admission were excluded.

For the sample-size calculation, we considered the number of children admitted to the PICU throughout 2023 (n = 456; January: 28; February: 28; March: 37; April: 38; May: 55; June: 44; July: 39; August: 46; September: 17; October: 32; November: 51; December: 40).

We then applied the single-population proportion formula, using a 5% margin of error and a 99% confidence interval. Prevalence was set at 5%, in line with the Infusion Nurses Society (INS) recommendation, which defines this value as the acceptable upper limit for the occurrence of phlebitis in pediatric and adult populations[16]. This parameter — widely used in clinical studies and practice[10] — serves as a sentinel marker of patient safety; rates above the recommended limit indicate care deficiencies and warrant review of institutional protocols and preventive strategies. The calculation yielded a target sample of 99 children. During data collection, two additional eligible participants were identified and included, resulting in a final sample of n=101.

Setting

The study was conducted in the PICU of a medium-sized public hospital in Teresina, Piauí, Brazil. The hospital is a tertiary referral center serving the state capital, multiple inland cities in Piauí, and neighboring states, chiefly Maranhão, Tocantins, and Pará. The hospital has 108 beds, 28 of which belong to a Type II PICU.

The unit operates with three daytime and three nighttime on-call teams composed of: 10 nursing technicians, four staff nurses, two daytime nurses, two psychologists, four physical therapists, four on--call physicians, two daytime physicians, two social workers, and two general services professionals. The PICU admits about 38 pediatric patients per month.

Measures

Sociodemographic and clinical data were collected by using a study-specific form including: age (years), sex (male/female), schooling (preschool/elementary), CVC dwell time (days), number of organ systems involved, medical diagnosis (pneumonia/other), admission type (medical/post-surgical), number of medications in use (oligopharmacy/polypharmacy), receipt of blood transfusion (no/yes), and use of antimicrobials (no/yes).

Presence or absence of phlebitis was assessed with the Portuguese Phlebitis Scale (Brazilian-adapted and validated version), which grades as follows: 0 = no symptoms; 1 = pain at or adjacent to the insertion site during infusion of a solution or medication OR erythema at the access site with or without pain; 2 = pain at the access site AND erythema AND/OR edema; 3 = pain at the access site AND erythema AND/OR edema AND redness along the vein path AND palpable venous cord; 4 = pain at the access site AND erythema AND/OR edema AND redness along the vein path, palpable venous cord > 2.5 cm in length, AND purulent drainage[17].

Data collection

Data were collected between April 2024 and June 2025 in a private setting provided by the hospital to ensure confidentiality. Interviews and assessments took place in a reserved room, attended only by the child's mother, father, or legal guardian and the researcher, on a pre-scheduled date and time.

Before data collection began, the assistant researcher completed a 12-hour training covering appro-

aches to potential participants; presentation of study objectives, procedures, risks, and benefits; administration of data-collection instruments; and assessment of CVCs using the Portuguese Phlebitis Scale. To ensure instrument adequacy, a pilot test was conducted with a sample similar to the target population, allowing identification of shortcomings and adjustments to the study protocol.

Data collection started with a semi-structured interview with the child's mother, father, or legal guardian, during which a form capturing sociodemographic and clinical information was completed. To supplement these data, medical records were reviewed with guardian authorization and, when feasible, the child's assent, to identify potential factors associated with CVC-related phlebitis.

Catheter was then clinically assessed at the bedside, in a single session, during dressing change, in a well-lit environment that enabled inspection of the insertion site and venous tract, with systematic application of the scale. Based on the Portuguese Phlebitis Scale criteria, the researcher recorded findings related to inflammatory signs and the CVC's severity grade. Mean data-collection time per child was about 35 minutes (30 minutes for the interview and 5 minutes for assessment of catheter). This standardized procedure was intended to ensure consistency, data reliability, and child safety.

Data analysis

Data from the instruments were double-entered into Microsoft Excel® spreadsheets (version 2016), validated, and then exported to IBM SPSS Statistics for Windows, version 21.0 (IBM Corp., Armonk, N.Y., USA). Descriptive analyses included absolute and percentage frequencies and measures of central tendency and dispersion (mean, minimum, maximum, and standard deviation) for continuous variables. Distribution normality was assessed with the Kolmogorov–Smirnov test, which supported the use of nonparametric tests. For inferential analysis, Fisher's exact test was applied, with a two-sided significance level of 5%.

Ethical considerations

Participation by mothers, fathers, or legal guardians was contingent on signing the informed consent form, and an assent form was provided to children capable of assenting. The study adhered to required ethical standards and was approved by the Research Ethics Committee at *Universidade Federal do Piauí* (Certificate of Presentation of Ethical Appreciation No. 78327924.7.0000.5660; Opinion No. 6,722,296/2024).

Results

Sample comprised 101 children aged from birth to 14 years, 11 months, and 29 days. The prevalence of phlebitis was 30.7% (31 cases). The only variable significantly associated with phlebitis was CVC dwell time ($p < 0.001$). Regarding severity, grade 1 predominated in 19 children (18.9%), followed by grade 3 in 5 (4.9%), grade 2 in 4 (3.9%), and grade 4 in 3 (3.0%) (Figure 1).

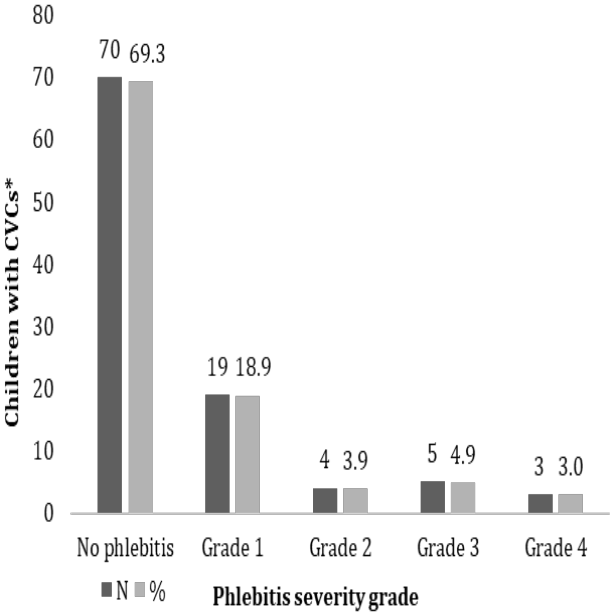

Figure 1 – Distribution of phlebitis severity among children with central venous catheters (n=101). Teresina, Piauí, Brazil, 2024–2025

Regarding the variable with a significant association, in most cases CVC dwell time was ≥ 6 days — 62 children (61.4%) — which constituted a relevant factor associated with phlebitis. No other variables showed significant associations. Among the variables examined, most children were 0–5 years old (76.2%); male (59.4%); attended preschool (82.2%); had involvement of a single organ system (71.3%), with pneumonia as the most common diagnosis (36.6%); were admitted for medical (nonsurgical) reasons (88.1%); received up to four medications (94.1%), most commonly antimicrobials (74.3%); and less frequently required blood transfusion (27.7%) (Table 1).

Table 1 – Sociodemographic and clinical characteristics of children with and without symptoms of phlebitis related to central venous catheters (n = 101). Teresina, Piauí, Brazil, 2024–2025

Characteristics	n (%)	Symptoms		p-value*
		Absence n (%)	Presence n (%)	
Ager (years)				1.000
0–5	77 (76.3)	53 (52.5)	24 (23.8)	
6–14	24 (23.7)	17 (16.8)	7 (6.9)	
Sex				0.518
Male	60 (59.4)	40 (39.6)	20 (19.8)	
Female	41 (40.6)	30 (29.7)	11 (10.9)	
Schooling				0.125
Preschool	83 (82.2)	55 (54.4)	28 (27.8)	
Elementary school (levels 1 and 2)	18 (17.8)	15 (14.8)	3 (3.0)	
Central venous catheter dwell time (days)				0.000
1–5	39 (38.6)	39 (38.6)	–	
≥ 6	62 (61.4)	31 (30.7)	31 (30.7)	
Organ systems affected				0.346
1	72 (71.3)	52 (51.5)	20 (19.8)	
≥ 2	29 (28.7)	18 (17.8)	11 (10.9)	
Primary diagnosis†				0.506
Pneumonia	37 (36.7)	24 (23.8)	13 (12.9)	
Other	64 (63.3)	46 (45.5)	18 (17.8)	
Admission type				0.099
Medical	89 (88.1)	59 (58.4)	30 (29.7)	
Post-surgical	12 (11.9)	11 (10.9)	1 (1.0)	
Number of medications in use				1.000
Oligopharmacy (≤ 4)	95 (94.0)	66 (65.3)	29 (28.7)	
Polypharmacy (≥ 5)	6 (5.9)	4 (4.0)	2 (2.0)	
Received blood transfusion				0.097
No	73 (72.2)	47 (46.5)	26 (25.7)	
Yes	28 (27.8)	23 (22.8)	5 (5.0)	
Use of antimicrobials				0.147
No	26 (25.8)	15 (14.9)	11 (10.9)	
Yes	75 (74.2)	55 (54.4)	20 (19.8)	

*Fisher's exact test; †Primary diagnosis

Discussion

This study sought to identify sociodemographic and clinical factors associated with phlebitis in children using CVCs. Approximately one-third of participants showed clinical signs suggestive of the complication — a prevalence 6.14 times higher than the 5% limit recommended by the INS[16].

The prevalence of phlebitis observed here was considerably higher than rates reported in national and international studies. The literature shows wide variation depending on the population profile and clinical context. In an international study of 2,974 children aged 0–18 years with hematologic diseases, the phlebitis rate associated with peripherally inserted central catheters was 9.5%[18]. Another investigation involving 584 patients aged 1–12 years reported a prevalence of 15%[19]. Among newborns using these catheters, prevalence reached 17.04%[20]. Thus, the present findings exceed previously documented va-

lues, suggesting greater vulnerability in this population and underscoring the need to review care protocols and preventive strategies.

Compared with adults, children face specific challenges in intravenous access, characterized by greater technical complexity, longer procedure times, and multiple puncture attempts — even by experienced professionals — especially at younger ages[21]. The use of CVCs in pediatric patients is particularly challenging due to anatomic limitations, such as thinner, more fragile veins, which complicate handling and increase the risk of endothelial injury. A further aggravating factor is the relatively high proportion of the vascular lumen occupied by the catheter, which contributes to blood-flow turbulence and, consequently, greater susceptibility to complications[1].

Children also tend to tolerate vascular access devices poorly; frequent attempts at self-removal and the fragility of anatomic structures compromise both insertion and the safe, effective maintenance of CVCs[22]. Thus, there is an urgent need to develop standardized techniques and protocols for inserting CVCs in children in order to strengthen and support nursing practice and ensure children's well-being and safety[23].

Technique is pivotal, as complications such as phlebitis are closely linked to how the procedure is performed. Phlebitis may arise when the catheter tip is not centrally positioned — particularly in smaller-caliber vessels, which are more prone to chemical irritation and continuous friction with the CVC. Other risk factors include excessive catheter stiffness, inadequate puncture technique, selection of insertion sites in highly mobile regions (e.g., upper limbs), local infection, and drug incompatibilities[24].

Despite these observations, there are currently no pediatric-specific clinical guidelines for CVC insertion in young children[4]. Many practices are still extrapolated from adult studies or rely solely on expert opinion[25]. This normative gap highlights the urgency of developing clinical protocols tailored to pediatric populations, with clear, systematic guidance on CVC selection, proper insertion, correct positioning, and ongoing CVC care — thereby reducing complications and promoting patient safety.

Venous access management is a nursing responsibility, and vascular-access complications — including phlebitis — constitute a patient-safety problem in the hospital setting[10]. Establishing best practices for managing CVCs in hospitalized children is therefore essential to optimize treatment[8]. Consistent reductions in phlebitis can be achieved by implementing evidence-based preventive interventions[26].

In this context, various interventions have been proposed and implemented to reduce CVC-related phlebitis. Prominent among these are educational programs aimed at enhancing nursing skills and standardizing care practices[4]. Complementarily, the adoption of clinical protocols is fundamental, encompassing careful selection of materials, safe insertion techniques, daily maintenance routines, and detailed documentation of all interventions[6].

The effectiveness of catheter-care measures has been investigated in recent years to inform best practices[23-24]. Evidence indicates that interventions such as hand hygiene, use of transparent dressings, application of rigid splints to immobilize joints, and heparin flushing after medication administration are associated with consistently lowering phlebitis rates to below 5%. These findings reinforce that evidence-based strategies are effective in minimizing this complication[26].

From a broader perspective, continuing education and ongoing team training to support rigorous CVC monitoring are essential preventive measures. Systematic CVC surveillance not only promotes early recognition of complications but also facilitates immediate corrective action, thereby reducing adverse events and improving the quality of care[6].

The epidemiological characteristics of children with CVCs in this study align with typical PICU populations. Most were 0–5 years old—the preschool period, marked by greater immunologic vulnerability and a higher need for intensive care in complex clinical sce-

narios — and there was a higher proportion of males, consistent with patterns described in the literature showing a slight male predominance among children requiring high-complexity pediatric care[27-28].

Clinically, respiratory diseases predominated, in line with prior reports[29-30]. The high use of antimicrobials commonly observed in PICUs may be linked to unfavorable outcomes; many physicians are reluctant to change or stop these drugs while a patient remains critically ill, which can lead to inappropriate or prolonged use and may be related to the large number of medications administered during hospitalization[28].

A statistically significant association was found between phlebitis and CVC dwell time ≥ 6 days, with 100% of phlebitis cases occurring within this interval. This suggests that prolonged catheterization is an important risk factor for complications such as phlebitis, corroborating evidence that extended CVC dwell time is associated with higher risks of infection, phlebitis, and difficult removals[11].

Mechanistically, the risk may reflect mechanical injury at insertion; over time, damaged endothelial and smooth-muscle cells adhere to fibrin, promoting thrombus formation. Prolonged exposure of the vessel to the catheter also increases the likelihood of platelet activation, triggering the coagulation cascade and thereby elevating thrombosis risk[2].

Accordingly, rigorous and systematic nursing surveillance is imperative for children requiring prolonged use of CVCs. Daily reassessment of the need for catheterization and prompt removal once the CVC is no longer clinically indicated are essential to maintain treatment continuity and safety. Although there is no definitive consensus on the ideal dwell time in PICUs, recent literature recommends not exceeding 7 days — and preferably keeping it under 10 days whenever possible[11].

Moreover, CVC removal and reinsertion should be guided by clinical indications, as there is no clear difference in phlebitis rates between clinically indicated and routine replacement; assessment of pain may serve as an early indicator of this complication[9]. Systematic assessment of phlebitis using validated scales is therefore advisable to support nurses' decision-making regarding therapeutic interventions and to evaluate the effectiveness of evidence-based preventive measures[17].

Study limitations

This study has several limitations. Data were collected at a single hospital. Only the number of medications administered via the CVC was considered, without distinguishing specific drug classes, and the type of phlebitis (mechanical, infectious, or chemical) was not assessed. The CVC material was not recorded, nor were possible concomitant signs of phlebitis, such as pain. The cross-sectional design also precludes causal inference and limits generalizability to other pediatric populations and clinical settings. Nevertheless, these limitations did not compromise the quality of the findings: the methods ensured the collection of relevant, consistent data, and the sample was representative of the target population.

Contributions to practice

The findings have important implications for public health and nursing practice. Continuous, rigorous monitoring of CVCs is needed to prevent and detect phlebitis early. Institutional leaders should be encouraged to implement policies, establish protocols, and provide ongoing education for professionals working in PICUs so that multidisciplinary teams are trained to recognize early signs of complications and promptly adopt preventive measures. By demonstrating an association between phlebitis and CVC dwell time, this study supports the recommendation to remove the CVC preferably by day 6 whenever clinically feasible. Such practice may reduce complication risk, enhance patient safety, and improve the quality of pediatric care.

Conclusion

Central venous catheter dwell time was in place was the only factor associated with phlebitis in children. All identified cases occurred in children whose central venous catheter remained in place for more than 6 days, which reinforces the association between longer dwell time and increased risk of complications. Continuous monitoring of catheter duration and prompt removal when no longer clinically indicated are essential to prevent adverse events and to inform the development of care guidelines tailored to this population's needs.

Authors' contributions

Conception and design or data analysis and interpretation: Sousa TA, Bezerra MAR. Drafting of the manuscript or critical revision for important intellectual content; final approval of the version to be published; and agreement to be accountable for all aspects of the work related to the accuracy or integrity of the manuscript: Sousa TA, Rocha KNS, Carneiro CT, Brito MA, Rocha RC, Moura MAP, Bezerra MAR.

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